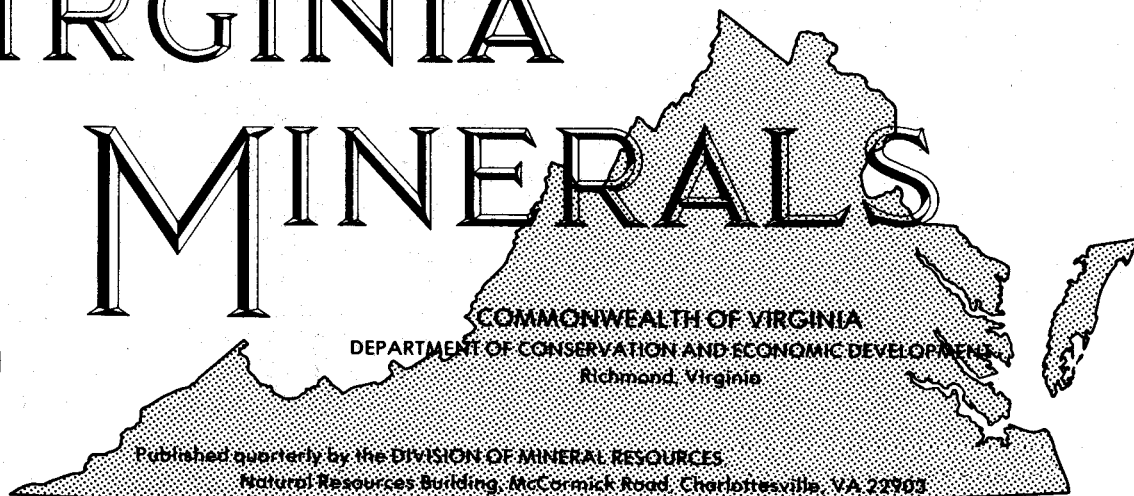


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## THE MIDDLE AND LATE PLEISTOCENE STRATIGRAPHY OF THE OUTER COASTAL PLAIN, SOUTHEASTERN VIRGINIA

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Late Cenozoic deposits of the outer Coastal Plain of southeastern Virginia consist of the Shirley formation (Johnson and Berquist, in preparation), which is middle Pleistocene in age, and the Tabb Formation (Johnson, 1976, and Peebles, in preparation), of late Pleistocene age. Each of these formations, which consists of various lithofacies, is bounded above and below by an unconformity. Accordingly, each is an alloformation. An alloformation is defined by the North American Commission on Stratigraphic Nomenclature (1983) as, "... the fundamental unit in allostratigraphic nomenclature... An allostratigraphic unit is a mappable stratiform body of sedimentary rock that is defined and identified on the basis of its bounding discontinuities."

Sediments which were deposited in embayed areas landward of barriers and along rivers exhibit upward-fining texture. When sea level fell and the sediments became emergent, a terrace (flat or rise) was created. The abandoned shoreline along the mainland (fastland) and rivers formed a scarp. Subsequent marine transgressions eroded the sediments underlying the older terraces and scarps mark the most landward extent of each marine transgression.

Economically valuable sand, gravel and

fill material may be found at the base of the upward-fining sequences. The formations as defined herein provide a framework for predicting the location of these resources. The stratigraphic framework is simpler, more accurate, and consequently more useful than the previous classifications.

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### STRATIGRAPHY

Deposits ranging in age from early Pliocene to late Pleistocene crop out in the outer Coastal Plain of southeastern Virginia. The stratigraphic succession under study includes the Yorktown, Chowan River, Shirley, and Tabb formations (Figure 2). Coch (1968, 1971), Oaks and Coch (1973), Ray and others (1968), Johnson (1976), Mixon and others (1982), Johnson and others (1981), and Darby (1983) discussed the Great Bridge, Norfolk, Kempsville, Londonbridge, and Sand Bridge

Table. Comparison of stratigraphic units used previously and in this report.

Series	This report	Darby (1983)	Mixon, Szabo and Owens (1982)	Johnson (1976) Johnson, Berquist, Ramsey and Peebles (1981)	Oaks and Coch (1973) Coch (1968, 1971)
Upper Pleistocene	Tabb Fm., Poquoson Mbr.	Not covered in report	Sand Bridge Fm.*	Tabb Fm., Poquoson Mbr.	Sand Bridge Fm.*
	Tabb Fm., Lynnhaven Mbr.	Norfolk Fm. (Upper Pleistocene)	Sand Bridge Fm.* Kempsville Fm.*	Tabb Fm., Lynnhaven Mbr.	Sand Bridge Fm.* Kempsville Fm.* Norfolk Fm.*
	Tabb Fm., Sedgefield Mbr.		Kempsville Fm.* Norfolk Fm. (type area)	Tabb Fm., Sedgefield Mbr.	Sand Bridge Fm.* Kempsville Fm.* Londonbridge Fm.* Norfolk Fm.* Great Bridge Fm.*
Middle Pleistocene	Shirley Fm.	Not present	Norfolk Fm. (West of Suffolk scarp) (Upper Pleistocene)	Norfolk Fm. (Upper Pleistocene)	Norfolk Fm. (clayey sand facies)
Upper Pliocene	Chowan River Fm.	Great Bridge Fm. (Upper ? Pleistocene)	Great Bridge Fm. (Upper Pleistocene)	Not present	Great Bridge Fm.* (Upper Pleistocene)

\* In part

formations in their reports. By identifying unconformities and mapping stratigraphic units at the scale of 1:24,000, new correlations between selected units have been made possible. This necessitates a revision of the currently-used nomenclature which was introduced by Coch (1968, 1971) and Oaks and Coch (1973). The Great Bridge Formation (Oaks and Coch, 1973; Nixon and others, 1982; and Darby, 1983) is herein shown to be part of the Chowan River Formation (Blackwelder, 1981) of late Pliocene age and the Tabb Formation of late Pleistocene age. The Norfolk Formation of Oaks and Coch (1973) is now considered to comprise two distinct formations separated by an unconformity: the Shirley formation (Johnson and Berquist, in preparation) and the Tabb Formation (Johnson, 1976; Peebles, in preparation). Sediments of the Sand Bridge, Kempsville, and Londonbridge formations of Oaks and Coch (1973) are herein considered to be facies within the

Sedgefield and Lynnhaven members of the Tabb Formation (Peebles, in preparation). Because of this confusion, we recommend dropping the use of Great Bridge, Norfolk, Kempsville, Sand Bridge, and Londonbridge as stratigraphic terms.

### YORKTOWN FORMATION

Within southeastern Virginia, the Yorktown Formation (Clark and Miller, 1906) consists of fossiliferous marine silty fine sand and crossbedded, biofragmental sand. Locally, the Yorktown underlies the Chowan River, Shirley, and Tabb formations. The Yorktown Formation is early to middle Pliocene (Akers, 1972; Nixon, written communication).

The silty sand facies (Johnson, 1969, 1972, and 1976) is composed of bluish-gray to greenish-gray fine sand intercalated with clayey silt. The fine sand is a mixture of quartz, calcium carbonate, and

subordinate amounts of glauconite, clay, heavy minerals, and phosphate. Bedding varies from massive to thick, and scour-and-fill structures are common. The sand is extensively bioturbated. Weathering of this facies removes the calcium carbonate and leaves a soft, gray, clayey fine sand residue which is mottled yellowish to reddish-brown. The fauna of the silty sand facies is dominated by mollusks, and includes diverse marine vertebrate and invertebrate assemblages. Although a majority of the bivalves are disarticulated, the shells are commonly whole and exhibit little or no evidence of abrasion.

The crossbedded coquina facies is exposed in the Yadkin and Chuckatuck pits and also underlies younger units in the Dismal Swamp and on the York-James Peninsula. This facies consists of yellowish-brown to bluish-gray, crossbedded biofragmental sand. The crossbed units range in thickness from 3 to 20 feet, and dip westward. Smaller scale crossbeds commonly dip northeast. Carbonate content in the crossbedded coquina facies may exceed 90 percent by weight. Glauconite, iron oxide, clay, and quartz are also present. Although the coquina is typically friable, it is locally indurated with iron oxide, siderite, and calcite. The coquina weathers to a spongy, light brown to reddish-brown clayey silt.

### CHOWAN RIVER FORMATION

The Chowan River Formation (Blackwelder, 1981) of late Pliocene age consists of interbedded silty fine sand, clayey silt, and biofragmental sand. Deposits of the Chowan River Formation are well exposed along the Chowan River in North Carolina; however these deposits occur only locally in the subsurface of southeastern Virginia. Because of the rare exposures of the Chowan River and because leaching of the shells within the Chowan River Formation renders the sediments similar to those of the Yorktown and Tabb formations, previous workers have placed Chowan River deposits in the Great Bridge (Oaks and Coch, 1973; Mixon and others, 1982; Darby, 1983) or in the Yorktown (Oaks and Coch, 1973; Barker and Bjorken, 1978). The formation rests unconformably on the Yorktown and is unconformably overlain by the Tabb Formation and, locally, Holocene deposits. The Chowan River is sporadic in distribution, its thickness ranging from

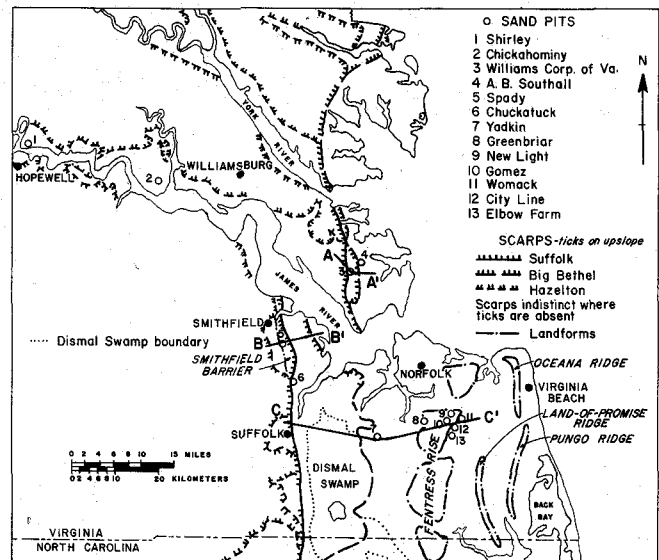


Figure 1. Location map with morphology and cross-section lines.

near zero east of the Suffolk scarp to approximately 20 feet at the Gomez pit (Figure 1). Oaks and Coch (1973) reported a thickness of the Great Bridge (Chowan River) of greater than 50 feet in the eastern Virginia Beach area.

The base of the Chowan River is characterized by a discontinuous pebbly to bouldery sand that rests on the leached and locally oxidized sediments of the Yorktown Formation. The largest boulders have a maximum diameter of 3 feet and the basal

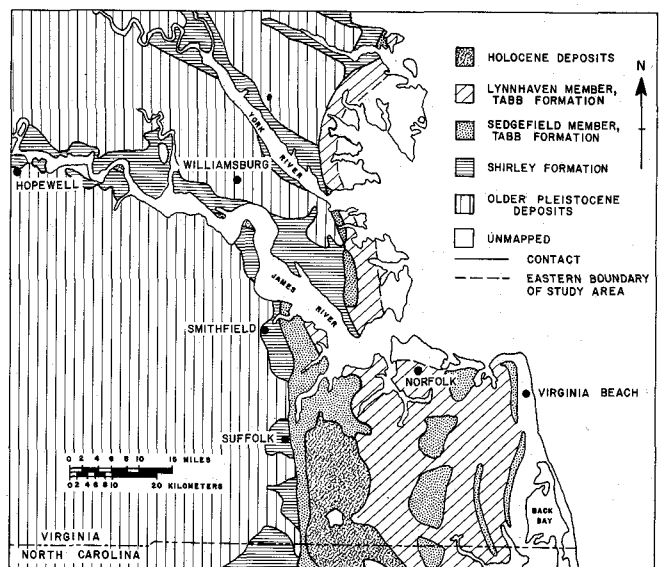


Figure 2. Generalized geologic map of southeastern Virginia.

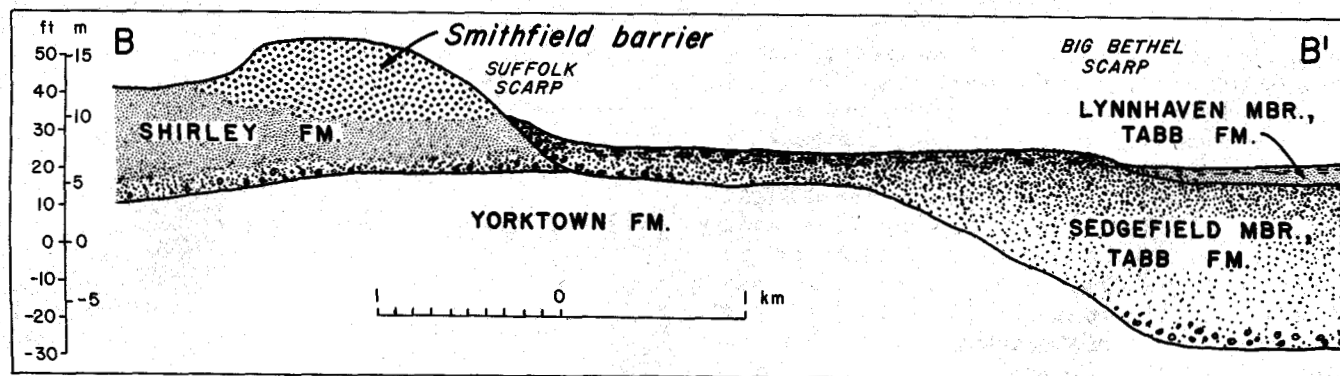


Figure 3. Geologic cross section B-B'.

lag deposit in the lower Chowan River includes a diverse suite of rocks from the Piedmont, Blue Ridge, and Valley and Ridge provinces. Septate nodules, ferricrete clasts, broken iron-oxide-cemented burrows, and phosphate pebbles, which were eroded from the Yorktown Formation, are also present (Victor, 1983).

The basal unit of the Chowan River grades upward into fine to medium sand, interbedded silty sand, clayey silt, and biofragmental sand. The clayey silt and silty sand contain bivalve ghosts and burrows. The biofragmental sands are crossbedded and contain a diverse, shallow-water fauna including *Argopecten eboreus*, *Glycymeris subovata*, *Ostrea compressirostra*, *Noetia limatula*, *Rangia*, *Corbicula*, and *Mercenaria*.

## SHIRLEY FORMATION

The Shirley formation is older than the type Norfolk Formation (Johnson and others, 1981; Mixon and others, 1982; Johnson and Berquist, in preparation), but others (Oaks and Coch, 1973) have mapped it as the clayey-sand, silty-sand, and coarse sand facies of the Norfolk Formation. The Shirley formation is named for exposures in the Lone Star pits at Shirley Plantation (Johnson and Berquist, in preparation). Deposits of the Shirley formation in the Williams Corporation of Virginia and Spady sand pits (Figure 1) are designated as reference sections. The revision of the nomenclature in this area was instigated because type Norfolk sediments were traced westward and were found to truncate older deposits. These older deposits were also mapped as Norfolk, but which we now recognize as Shirley. This relationship previously has confounded attempts at correlation into southeastern Virginia.

The Shirley formation is the surficial deposit between the Hazelton and Suffolk scarps, and is locally found in the subsurface east of the Suffolk scarp. The formation ranges in thickness from a featheredge against the Hazelton scarp to more than 80 feet in paleochannels. The Shirley rests disconformably upon older Pleistocene formations in the outer Coastal Plain and on progressively older sediments of the Chesapeake and Pamunkey groups up the James River and other major rivers of the Coastal Plain. Shirley sediments exhibit an overall upward-fining trend except in the Smithfield barrier deposits (Figure 3).

At the base of the Shirley formation there is a discontinuous pebbly to bouldery sand. The pebbles, cobbles and boulders range from well-rounded to angular and were derived from rocks of the Piedmont, Blue Ridge, and Valley and Ridge provinces. The largest clasts in these deposits are 5 feet in diameter. Planar and cross-stratified, well sorted, gray to light brown, fine to pebbly, coarse sand overlies the basal part of the formation. Although predominantly quartzose, the sands are locally feldspathic. Trough and planar crossbedded sets as much as 4 feet in thickness dip predominantly east to southeast. Graded bedding is common and the clasts range from matrix to clast supported. Locally, the sand is cemented by iron and manganese oxides.

The lower Shirley (Figure 4) contains discontinuous laminated to massively bedded, gray, organic-rich silt and clay and peat, which are locally more than 14 feet thick. The peat is fibrous to sapric, and contains selenite, *in situ* tree stumps, and other remains of beech, cypress, hickory, oak, pine, sweet gum, and *Walteria*. Intercalated, relatively thin beds of light gray to light brown, fine to coarse sand

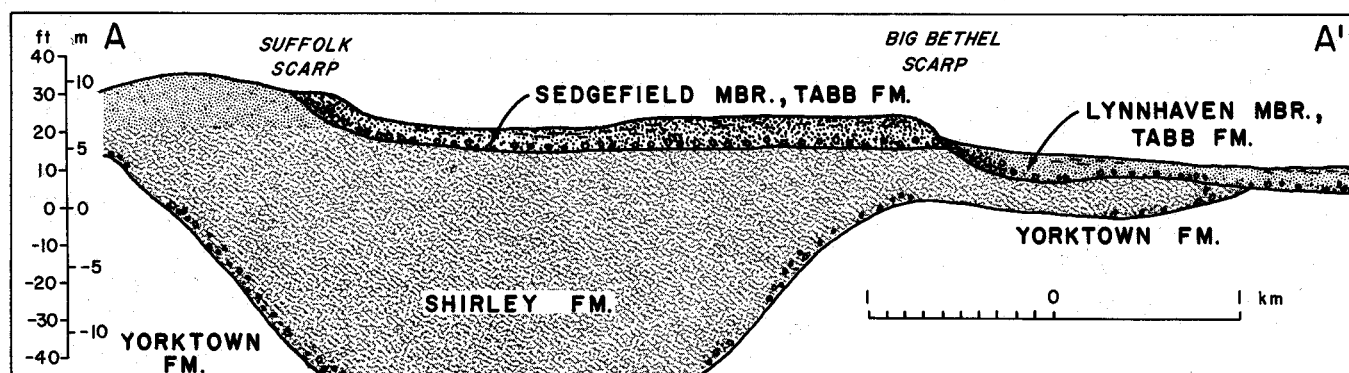


Figure 4. Geologic cross section A-A'.

and silt comprise the middle part of the Shirley formation. The interbedded sand and silt are cross-stratified and exhibit highly variable dip directions. Locally, flaser bedding is developed, especially in the lower reaches of the estuarine sediments. Organic material is less abundant than in the lower Shirley, and marine burrows and *Crassostrea virginica* beds have been found in the eastern York-James peninsula.

The upper part of the Shirley formation consists of medium to massively bedded, gray clayey sandy silt and silty clay. The silt, which is predominantly quartzose, contains disseminated mica, heavy minerals, and organic matter. This part also contains scattered pebbles and grades laterally into pebbly sand near the Hazelton scarp. The bedding ranges in thickness from less than 2 inches in the lower part of this unit to more than 4 feet in the upper part.

The Shirley formation in the Smithfield-Bennis Church area contains a basal cobble-pebble unit overlain by bluish-gray, fossiliferous silty fine sand and sandy silt, and overlying crossbedded, pebbly, fine to medium sand. Locally, peat and an organic-rich silt occur at the base of the fossiliferous silt and sand. Tree stumps and other plant remains have been found in these deposits. The silty fine sand grades upward into sandy silt. These deposits range from thin to thick-bedded and contain interbeds of fine sand and clayey silt. The fauna includes *Mulinia*, *Noetia*, *Epitonium*, *Nassarius*, and other mollusks. Many shells are articulated and in living position. The overlying pebbly sands occur as thin sheets or lenticular bodies; crossbeds dip predominantly westward. The lower part of this coarse sand unit grades westward into silty sands (Figure 3).

## TABB FORMATION

The Sedgefield and Lynnhaven members of the Tabb Formation (Johnson, 1976) constitute most of the surficial deposits east of the Suffolk scarp. Previously, parts of the Tabb Formation were mapped as the Great Bridge, Norfolk, Londonbridge, Kempsville, and Sand Bridge formations (Coch, 1968, 1971; Oaks and Coch, 1973; Johnson, 1972; Mixon and others, 1982; and Darby, 1983). Peebles (in preparation) correlates deposits of the Tabb Formation from the York-James Peninsula, where it was originally defined, to south of the James River (Figures 1 and 2).

At most localities, the Sedgefield and Lynnhaven members of the Tabb Formation consist of an upward-fining sedimentary sequence. Lithologies of the two members are similar; however, sediments of the Lynnhaven Member are generally finer and non-fossiliferous. An unconformity separates the Sedgefield Member from the Lynnhaven Member. Members of the Tabb Formation also exhibit unconformable relationships to the older deposits in the area, and are late Pleistocene in age (Johnson, 1976; Mixon and others, 1982).

## Sedgefield Member

Deposits of the Sedgefield Member of the Tabb Formation (Johnson, 1976) (Figure 2) range in thickness from a featheredge at the Suffolk scarp to more than 60 feet where they fill paleochannels. The lower part of the Sedgefield Member rests unconformably on the Yorktown, Chowan River, and older Pleistocene formations. On the York-James Peninsula, the unconformable relationship between the Sedgefield Member and the fluvial-paludal deposits of the Shirley formation can be seen at the sand pit of the Williams Corporation of

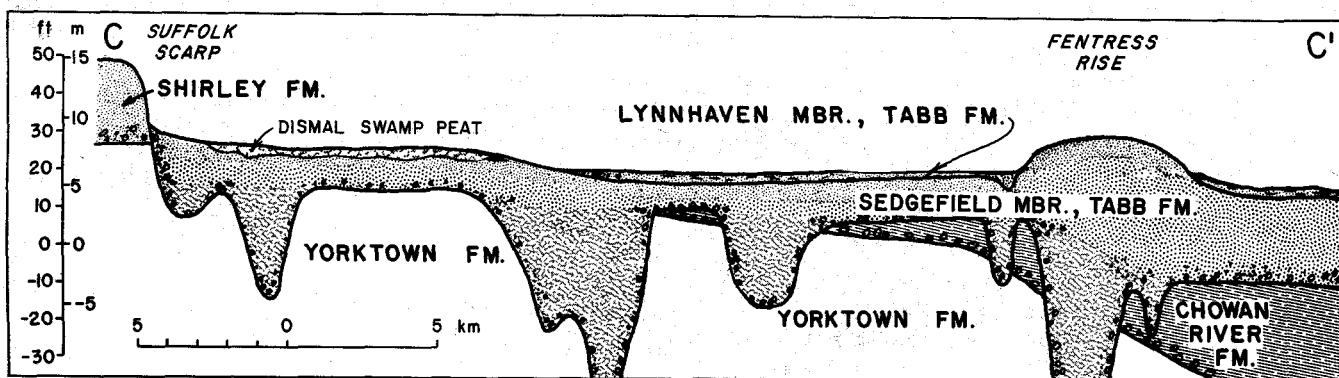


Figure 5. Geologic cross section C-C'.

Virginia. The unconformable relationship between the Sedgefield Member and the Chowan River Formation can be seen at Yadkins, City Line, Elbow Farm, and Gomez sand pits (Figure 1). The unconformable relationship between the Sedgefield Member and the Yorktown Formation can be observed at the Williams Corporation of Virginia and A. B. Southall sand pits on the York-James Peninsula and also in subsurface borings throughout most of the study area.

At the base of the Sedgefield Member are paleochannels ranging in width up to 30 feet and in depth as much as 60 feet (Figure 5). Excellent examples of these features are preserved at the Gomez, City Line, and Elbow Farm sand pits. The paleochannels are lined with pebbly to cobbly, fine to coarse sand and are filled with an organic-rich silty clay containing tree trunks in living position as well as tree branches and stems. In its upper part, this organic-rich silty clay contains *Crassostrea*, *Polynices*, and *Cyrtopleura*, along with wood fragments. Locally these valley-fill deposits are truncated by fine to medium sand or by fossiliferous pebbly to cobbly, fine to coarse sand. The pebbly to cobbly, fine to coarse sand extends laterally as a discontinuous basal sheet up to 2 feet thick throughout the aerial extent of the Sedgefield Member.

Sediments overlying the coarse basal portion of the Sedgefield Member vary geographically. Between the Suffolk and Big Bethel scarps, the basal pebbly to bouldery, coarse sand grades upward into a fine to medium sand which grades upward into a fine-sandy, clayey silt. The middle part of the Sedgefield Member is a fine to medium, gray to yellowish-brown quartz sand which varies in thickness up to 10 feet. Where these sands are well-drained, ferricrete and manganese oxide zones form

at the water table. The overlying fine-sandy clayey silt, which is as much as 2 feet thick, is generally light gray with yellowish-brown mottling, and typically lacks any discernible bedding.

Sediments of the Sedgefield Member are also present in the the Fentress rise, Oceana ridge, and in the subsurface east of the Big Bethel scarp. Underlying the Fentress rise, the basal cobbly to bouldery coarse sand grades upward into a fine to medium quartz sand containing a moderate amount of heavy minerals. Within these sands there are horizontal, fossiliferous beds dominated by *Mercenaria mercenaria* and serpulid worm bioherms, both in living position. An excellent example of this zone can be seen at the Gomez sand pit. Where groundwater has leached fossil shells, abundant ghost fossils are visible; sometimes the periostracum of leached *Mercenaria* shells is preserved (Darby, 1983). The fine to medium sand grades upward into pebbly, fine to very coarse sand in crossbeds which dip up to 10 degrees to the southeast. Laterally, there are local multidirectional crossbeds which dip as much as 30 degrees. The sediments overlying the crossbedded sands consist of locally channelized, indistinct horizontal beds of fine sand, clay and silt; the fine-grained sediments commonly contain scattered pebbles.

In the subsurface east of the Big Bethel scarp, sediments of the Sedgefield Member underlying the Mt. Pleasant flat also consist of a pebbly to cobbly, fine to coarse-sandy basal zone overlain by a *Crassostrea*-rich zone and grading upward into a light gray, fossiliferous fine sand. The faunal assemblage includes *Busycon*, *Spisula*, *Polynices*, *Mercenaria*, *Anadara*, cheilostomatous bryozoans, and abundant echinoderm fragments. These fossils occur

in abundance at the City Line and abandoned Womack pits, but only in thin zones in the Elbow Farm sand pit where they are mostly leached.

### Lynnhaven Member

The Lynnhaven Member of the Tabb Formation (Johnson, 1976) comprises surficial deposits east of the Big Bethel scarp and are as much as 11 feet thick. Near the Big Bethel scarp on the York-James Peninsula, the Lynnhaven Member is composed of gray, fine to coarse sand which commonly contains abundant pebbles, cobbles, and boulders. East of the Big Bethel scarp on the York-James Peninsula the Lynnhaven Member consists of a sporadic basal cobbly or pebbly, fine to coarse sand which grades upward into a clayey fine sand and silt unit with scattered coarse sand and pebbles. The cobbly zone is typically only one clast thick, and rests directly upon the leached or oxidized silty sand facies of the Yorktown Formation. However, where this basal portion overlies the fluvial and paludal channel-fill deposits of the Shirley formation, the sediments consist of pebbly, fine to medium sand. The clasts are lithologically similar to those in the Sedgefield Member but are not coated or stained with iron oxide. The boulder and cobble-rich part exhibits poorly developed planar bedding and grades upward into light brown to light gray, thin to medium-bedded, pebbly, fine sand. Heavy mineral laminae up to 1.5 inches thick occur in the crossbedded sands.

South of the James River, the basal part of the Lynnhaven Member generally consists of much finer-grained sediments than it does on the York-James Peninsula. Near the Big Bethel scarp south of the James River, the basal portion of the Lynnhaven Member consists locally of gray, fine to medium sand, but most commonly it is comprised of gray, silty fine sand or fine-sandy silt. Only one channel has been observed at the base of the Lynnhaven Member; this channel is approximately 30 feet wide, clearly truncates burrowed, clayey silt of the upper part of the Sedgefield Member, and is filled with crossbedded fine to coarse sand where beds dip 30 to 45 degrees southeast. This channel was observed at Yادkins pit (Figure 1).

The basal part of the Lynnhaven Member grades upward into silty fine sand and silty clay. Locally, there are interbeds of

silty clay, silty fine sand, and fine sandy silt; fine-grained sediments commonly contain scattered pebbles. Deposits of the Lynnhaven Member unconformably overlie deposits of the Sedgefield Member east of the Big Bethel scarp and at the toe of the Fentress rise, Oceana ridge, Land-of-Promise ridge, and Pungo ridge (Figure 5).

### GEOLOGIC HISTORY

The Yorktown and Chowan River, Shirley and Tabb formations record transgressive-regressive cycles during the late Cenozoic. During each low stand of sea level following regression of the sea, streams cut valleys into older Coastal Plain deposits and fluvial deposits accumulated in portions of these lowlands. Subsequent marine transgressions lowered the gradients of streams, trapping the fluvial sediments and allowing paludal deposits to accumulate on the fringes of the recently drowned valleys. As the sea continued to transgress landward, estuaries developed and the paludal deposits graded upward into estuarine clay, silt, and fine sand. Consequently, paleochannels, which are filled with fluvial, paludal, and estuarine deposits, are commonly found at the base of late Pliocene and middle and late Pleistocene formations. The basal deposits of these paleochannel fills rest upon truncated older deposits.

During each marine transgression, deposits of pebbly to bouldery, fine to coarse sand accumulated as discontinuous basal sheets as shorelines advanced landward. Sediments eroded from older deposits were reworked along the shoreline during the marine transgression. Whereas the finer-grained sediments were winnowed, the coarser sediments remained as a basal lag deposit which extended landward as a discontinuous sheet during marine transgression.

The coarse basal lag deposits of each Pleistocene formation grade upward into relatively finer-grained sediments which accumulated in protected embayments landward of barriers. During high stands of sea level these protected embayments continued to fill in with sediments. The silty fine sands and fine-sandy silts which occur at the top of the gradational sequence found in each Pleistocene unit accumulated in marshes and tidal flats. The upper surface of these deposits became terraces when sea level dropped.

During the early Pliocene, the sea



transgressed the Coastal Plain, depositing the silty fine sand facies of the Yorktown Formation. Differential movement of the outer Coastal Plain along deeply buried, steeply inclined faults produced a major linear shoal in the Chuckatuck-Yorktown-Yadkin area (Johnson and Peebles, 1983), where a crossbedded coquina facies accumulated. After regression of the Yorktown sea, the emergent Coastal Plain was weathered and dissected by streams.

In late Pliocene time, the advancing Chowan River sea reworked the older marine and fluvial sediments creating a basal lag concentrate. Fossiliferous fine sands and crossbedded biofragmental sands were deposited in a relatively warm, shallow, nearshore marine environment. Faunal assemblages indicate a brackish water influence locally. Subsequently, sediments of early to middle Pleistocene age were deposited during several marine transgressions.

During the middle Pleistocene, fluvial and paludal sediments began to accumulate in channels which had been cut into older Coastal Plain deposits during the preceding low stand of sea level. Pebbly to bouldery, coarse sand accumulated under fluvial conditions at the base and along the margins of the channels. These coarse deposits graded upward into fine sand, peat, and organic-rich silt and clay which accumulated in the channels as a result of stream gradient reduction during sea level rise. As sea level approached 45 to 50 feet in elevation, the Hazelton scarp (Oaks and Coch, 1973) was cut parallel to rivers as well as along the oceanic shoreline. Basal coarse lag deposits accumulated as a discontinuous sheet as the Shirley shoreline advanced landward. Local spits and barriers, such as the Smithfield barrier, formed along the shoreline. A barrier system existed farther east during this time, allowing finer-grained sediments to accumulate above the coarse basal lag deposits. This resulted in the upward-fining sequence which now constitutes the Shirley formation.

During the subsequent marine regression, streams cut into the Shirley and older formations. Stream gradients were again reduced during the next rise of sea level, and fluvial, paludal, and estuarine deposits accumulated in the channels. The upper part of the channel fill deposits is partially truncated by the coarse, basal lag deposits which formed as the Sedgefield

sea transgressed landward, reworking older Pleistocene and Tertiary deposits. This basal sheet of lag deposits also truncates the Chowan River Formation at the Gomez and Yadkin sand pits. At most other exposures in the area the coarse basal deposits of the Sedgefield Member bevel Yorktown sediments. Except in parts of the York-James Peninsula where the basal deposits truncate paleochannel deposits off the Shirley formation, Sedgefield channel-fill deposits grade upward into fossiliferous fine sand and silt of the ancestral Chesapeake Bay. In the Gomez and New Light sand pits, tidal inlet channel sediments and bedding structures indicate a barrier origin for these deposits. These barrier sands migrated landward covering the ancestral Chesapeake Bay deposits. East of the Fentress rise, the barrier sand of the Sedgefield Member grades laterally into fossiliferous, nearshore marine fine sand. The faunal assemblage within this fine sand is indicative of a warm, shallow shelf. West of the Sedgefield barrier complex, finer-grained sediments accumulated in a quiet embayment. These finer-grained sediments constitute the upward-fining sequence of the Sedgefield Member which underlies the Churchland flat.

The Fentress rise became sediment-starved with the development of the Oceana ridge. It is evident that Sedgefield sediments underlie the Oceana ridge, because these barrier sediments intertongue with Sedgefield bay sediments to the west. Tidal marsh sediments consequently accumulated above the barrier sediments of the Fentress rise. As sea level fell, streams eroded into the Sedgefield and older deposits. The subsequent Lynnhaven marine transgression reduced stream gradients and allowed fluvial deposits to accumulate in channels which had been carved during the preceding marine regression. The discontinuous basal sheet of lag deposits of the Lynnhaven Member is coarser and thicker on the York-James Peninsula than south of the James River. Also, the Big Bethel scarp is not as prominent south of the James; apparently, the Fentress rise, Oceana ridge, Land-of-Promise ridge, and Pungo ridge served as a barrier complex, protecting the fastland from shoreline erosion. On the York-James Peninsula and south of the James River, the coarse basal deposits of the Lynnhaven grade upward into a silty fine sand to silty clay which accumulated to thicknesses of up to 11 feet in a back-barrier



environment protected by these eastern ridges.

## CONCLUSIONS

Stratigraphic relationships observed in the outer Coastal Plain of southeastern Virginia record two Pliocene and three middle to late Pleistocene marine transgressive-regressive cycles. Sediments of the Yorktown, Chowan River and Shirley formations and the Sedgefield and Lynnhaven members of the Tabb Formation accumulated during marine transgressions. These stratigraphic units are unconformable with respect to each other.

Sediments within the Shirley formation and the Sedgefield and Lynnhaven members of the Tabb Formation generally exhibit an upward-fining sequence with channel deposits occurring locally at the base of each sequence. The channels are filled with fluvial deposits and grade upward into paludal and estuarine deposits which accumulated when stream gradients were reduced during marine transgression. A discontinuous sheet of pebbly to bouldery, fine to coarse sand partially truncates the channel-fill deposits and occurs at the base of each marginal-marine sequence. The coarse basal deposits formed as the sea transgressed landward, eroding and reworking older deposits. Finer-grained sediments from these older deposits were winnowed, while coarser-grained sediments remained as a sheet of lag deposits.

The coarse basal deposits of each stratigraphic unit generally grade upward through fine to medium sand and into silty fine sand or silty clay. Barriers existing to the east during each Pleistocene marine transgression created protected embayments where finer-grained deposits accumulated.

Recognition of facies relationships within each stratigraphic unit allows an integrated, consistent approach to unravelling the stratigraphy in the outer Coastal Plain of southeastern Virginia. This perspective permits a more accurate revision of the stratigraphic nomenclature used in this area. The Shirley formation is informally recognized, and sediments of the Sedgefield and Lynnhaven members of the Tabb Formation underlying the York-James Peninsula are correlated with deposits of other areas in southeastern Virginia. Unconformities separating the various units have been delineated, and predictable, recognizable sedimentary sequences within each stratigraphic unit have been described.

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## MINERAL UPDATE

### GOLD - SILVER REDISCOVERED IN OLD AMHERST COUNTY MINE

D. Allen Penick, Jr. and Palmer C. Sweet

A gold-silver mine previously unreported in Amherst County records has recently been investigated by the writers. The mine, referred to as the Buck Mountain mine in this report, was brought to the attention of the Virginia Division of Mineral Resources by Mr. Herbert L. Grow of Rockbridge County. Additional information was provided by Mr. William Sandidge of Amherst and Mr. Jasper Tomlin of Vesuvius. Very little is known about the history of the mine except that it was in operation for a brief period about 60 years ago. According to Mr. Tomlin the ore was hauled down the steep mountain on horseback and transported by wagon over the Blue Ridge to Buena Vista, a distance of about 8 miles. The destination of the ore from this point is not known. Mr. Sandidge recalls that the low price of silver during this period precluded further development of the mine.

The Buck Mountain mine is located in Amherst County about 4.65 miles north of the Forks of Buffalo in the northwestern corner

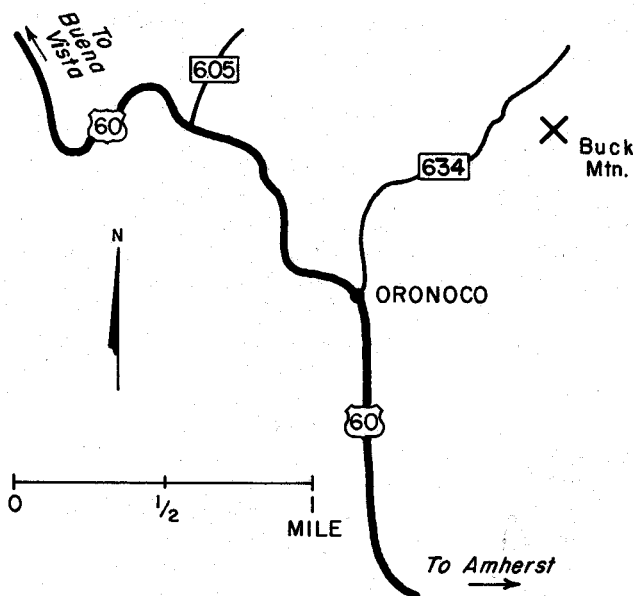


Figure 1. Location of Buck Mountain mine, Amherst County.

of the Forks of Buffalo 7.5-minute quadrangle. The specific location is about 1 mile northeast of U.S. Highway 60, 0.2 miles southeast of state road 634 and on the northwest side of Buck Mountain at an elevation of about 2,640 feet (Figure 1). The property is owned by Jasper Tomlin of Vesuvius. The mine represents one of the few occurrences of gold-silver mineralizations in the Blue Ridge province from which ore was actually shipped.

The mine was developed by a 10-foot square vertical shaft 15 feet deep and an adit northeast of the shaft which was cut into the hillside for about 20 feet. The shaft and adit workings are not connected, although this appeared to be the original



Figure 2. Steeply dipping shear zone (14 inches thick) exposed at adit entrance.



Figure 3. Underground contact between shear zone (right) and country rock containing disseminated sulfide mineralization.

plan. There is about 14 inches of black, altered, metallic sulfide mineralization exposed in the shaft as well as in the adit tunnel to the northeast (Figure 2). The main ore zone appears to be concentrated in this 14-inch thick shear zone. However, disseminated mineralization was observed in the country rock up to a thickness of 3 feet directly adjacent to the shear zone. This contact shows up well in the underground workings (Figure 3). A grab sample of this combined material was taken and sent to Barringer Resources, Inc., in Sparks, Nevada, for fire assay analysis; the report indicates 5.4 ounces of silver per ton and 0.070 ounces of gold per ton.

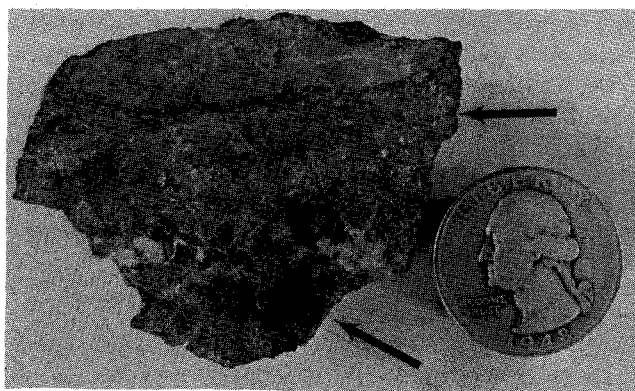


Figure 4. Primary sulfide minerals--pyrite and arsenopyrite (upper arrow). Lower arrow shows cavities filled with the secondary mineral scorodite (iron arsenate). Scorodite occurs as small green botryoidal masses with drowsy crystalline surfaces. Gold-silver mineralization may occur within these two areas (Photograph by Dave Hubbard).

The host rock associated with the Buck Mountain mineralization is a granitic type rock that appears to be a charnockite containing hypersthene as the chief mafic constituent. This rock is partly an intrusive and partly a granulite facies of a metamorphic rock. This host rock, which falls within the Pedlar Complex (Precambrian) appears to be quite similar to that found at the Irish Creek tin deposit some 10 miles to the north.

The principal minerals found associated with the mineralized zone and verified by X-ray analysis, are fluorite, pyrite, quartz, mica, gypsum, arsenopyrite, and scorodite. Arsenopyrite and scorodite (Figure 4) are two arsenic minerals which, to date, have not been reported from Amherst County. There is a good possibility that the gold-silver mineralization is associated with these two minerals. Both gold and silver have been reported to occur in arsenopyrite veins at Irish Creek. (Glass, J. J., Koschmann, H. A. Vhay, J. S., 1958, Minerals of the cassiterite-bearing veins at Irish Creek, Virginia, and their paragenetic relations: Economic Geology, vol. 53, p. 81-82). Scorodite is also found in some abundance at Irish Creek. In general, the country rock and minerals associated with the Buck Mountain mine are similar to the rocks and minerals at the Irish Creek deposit, although tin minerals have not been observed at Buck Mountain.

## LORA ROBINS GALLERY EXHIBITION

The Lora Robins Gallery has announced that an exhibition of gems, jewelry, minerals, and fossils will be held October 19-21, 1984 at the Robins Center on the University of Richmond campus. The hours will be Friday, noon to 9:00 p.m.; Saturday 10:00 a.m. to 9:00 p.m.; and Sunday 10:00 a.m. to 6:00 p.m. Admission is to be \$2.50 (persons under 12 and students free).

THE LORA ROBINS GALLERY was established in 1977 as a Learning Resource of the University of Richmond. The Gallery houses collections of gems, jewelry, rocks, minerals, and fossils, which are exhibited in both scientific groupings and with displays of cultural artifacts relating natural history to countries and cultures. The Gallery is located in the Boatwright Library and is open to the public without charge during library hours.

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## MINERAL RESOURCE NEWS

The value of Virginia's nonfuel mineral production in 1982 was 263.18 million dollars, and in 1983 preliminary figures indicate an increase of more than 20 million dollars to 283.19 million dollars. Per capita nonfuel mineral production value in Virginia for 1983 was \$51.68 per person. The value is about four times larger than the fishing industry. The 1982 figures for Virginia including coal, oil, and gas (1.7 billion dollars) are about 25 times the value of the fishing industry. Tourism amounts to about 3 billion dollars per year in Virginia.

The economic slowdown that developed during the later part of 1979 continued through 1982 but turned around in 1983, with the majority of the value increase in cement and clay. The commodities of clay, sand and gravel, and stone decreased during the years 1979-1982 with these commodities increasing in total value in 1983. The State led the Nation in the production of kyanite; was the only producer of a feldspar marketed as "Virginia aplite" and was one of three states mining vermiculite. Several mineral commodities--iron oxide pigments, lithium carbonate, magnetite, manganese, mica, perlite, and vanadium pentoxide (until

mid-1982) were imported into the State and processed.

Luck Stone Corporation has moved their portable plant from Elkton, Rockingham County to their Greene County site near Ruckersville. The plant has been set up and is presently crushing. The company is also seeking rezoning of a 432-acre tract near Dutoy Creek in eastern Powhatan County for mining and mineral extraction uses. They have been turned down twice in the past by the Powhatan Planning Commission.

Virginia Polytechnic Institute and State University has concluded a six-month study to determine the extent of contamination from the old American Cyanamid plant site at Piney River in Amherst-Nelson counties and developed recommendations on how to deal with it. The State Water Control Board paid \$35,000 for the study. The report offered alternatives ranging from eliminating any large fish kills to putting the problem away forever; range of costs varies from \$500,000 to \$5 million. Six major fish kills have taken place in the nearby Piney and Tye rivers from 1977-1981. The State of Virginia is suing current and former owners of the site to determine who is responsible for financing the cleanup.

U.S. Gypsum Company has acquired the high-calcium operation of Gold Bond Building Products, Division of National Gypsum Company at Kimballton in Giles County. The company plans on some renovative work and to continue to run the operation as before.